REMARKS

This paper is presented in response to the final official action dated January 13, 2011, wherein (a) claims 1-44 were pending, (b) claims 1-15. 39, and 40 were withdrawn from consideration, (c) claims 16-39 [sic, 16-38] and 41-44 were rejected for indefiniteness, (d) claims 16-21, 23-27, 29, 30, 32-36, 38, and 41-43 were rejected as being obvious in view of the three-way combination of Nakata, Probst, and Levine, (e) claims 22 and 28 were rejected as being obvious in view of the four-way combination of Nakata, Probst, Levine, and Yoshikawa, (f) claim 31 was rejected as being obvious in view of the four-way combination of Nakata, Probst, Levine, and Hogel, and (g) claims 37 and 44 were rejected as being obvious in view of the four-way combination of Nakata, Probst, Levine, and Tsuzuki.

By the foregoing, claim 16 has been amended and claims 27 and 28 have been canceled. Claims 16-26, 29-38 and 41-44 remain at issue, with claim 16 being independent.

Claim 16 is amended to incorporate the limitation of previous claim 28 and to recite that the substrate cores are glass substrate cores, support being found in claim 28 and on page 11, lines 15 to 18, for example. The claim is also amended for clarity to recite that the separation cuts penetrate the conductive front contact layer comprising a TCO and the conductive back contact layer on the side of the support layer that is opposite from the front contact layer, support being found in Fig. 3(a), for example.

Reconsideration of the application, as amended, is solicited.

The issues raised in the official action are addressed below in the order in which they appear in the action.

Claim Rejections – 35 USC 112

The indefiniteness rejections are moot, in view of the amendment to claim 16; reconsideration and withdrawal of the rejections are therefore solicited.

Claim Rejections – 35 USC 103

All elected claims 16-38 and 41-44 stand rejected as being obvious over various combinations of references, each rejection relying on the base combination of Nakata, Probst, and Levine. Claims 27 and 28 have been canceled. The remaining rejections are moot in view of the claim amendments or in the alternative are respectfully traversed, and reconsideration is requested.

The present invention differs from what the skilled artisan would arrive at by combining the prior art at least by (a) use of a transparent conductive oxide (TCO) front contact and (b) use of a spherical or grain-shaped glass substrate core coated at least with one conductive back contact layer made of molybdenum and with one semiconductor layer made of a I-III-VI compound semiconductor.

TCO Front Contact

Regarding prior claim 28, the elements of which are now incorporated in claim 16, the official action states that Yoshikawa (US 6,586,670) teaches that aluminum, copper and TCOs are art-recognized equivalent conductive materials in the solar art and that it would have been obvious to use copper and TCOs as conductive components of modified Nakata.

While is it correct that Yoshikawa (US6586670) discloses various conducive materials, which may be used as conductive layer in a photoelectric conversion device as described in Yoshikawa, it does surely neither disclose nor suggest that these materials are equivalent, especially for the arrangement of Levine. It does

accordingly also neither disclose nor suggest that they may replace one another in the specific arrangement now claimed.

One skilled in the art will realize that there are obvious differences between metals (copper and aluminum) and TCOs, even if both are conductive materials as disclosed in Yoshikawa.

The basic difference concerning the nature of the materials (metals versus oxides) actually leads to differences for example concerning the electrical conductivity as well as the mechanical properties. Moreover, while metals may be used as foils as recited in Levine, TCOs may be obtained only as deposited layers. This of course also leads to different mechanical properties for metal foils and TCO layers. Actually, metal foils may be quite though and malleable whereas a deposited thin TCO layer is rather quite fragile and brittle.

It should thereby be noted that Levine discloses the use of a metal foil supporting layers of polymeric material disposed on opposite sides, whereby little silicon spheres are inserted therein. The metal foil thereby supports the polymeric layers and holds the sphere, so as to provide stability to the arrangement.

Moreover, it is noteworthy that Levine teaches that a problem solved by the invention is to ensure that the cells can be made flexible (see column 1, lines 25 to 30). In this respect, Levine also further teaches that the metal foils used have a distinct malleable characteristic (see column 4, lines 49 to 51).

The question is thus would one skilled in the art contemplate the replacement of the metal foil providing mechanical stability and flexibility (distinct malleable characteristic) to the arrangement of Levine by a thin deposited TCO layer in view of the prior art (especially Levine). This combination is not motivated by the prior art because it would change the principle of operation of Levine or render it unsatisfactory for its intended purpose. See MPEP § 2143.01 (VI) and (V), respectively:

> If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. In re Ratti, 270 F.2d 810, 123 USPQ 349 (CPA 1959).
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> If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. In re Gordon, 733 F. 2d 900, 221 USPQ 1125 (Fed. Cir. 1984)

One skilled in the art could not expect a deposited TCO layer to provide the toughness and the mechanical stability achieved using by the metal foil disclosed in the arrangement of Levine. In addition, deposited TCO layer will also be unable to provide a distinct malleable characteristic as required by Levine for the metal foil. This is of course due to inherent differences between a metal foil and a thin deposited oxide layer (as explained above).

It should thus be realized that Levine actually teaches away from using a thin deposited TCO layer instead of the metal foil, since the metal foil is used to provide the mechanical stability to the arrangement in Levine and Levine especially requires a distinct malleable characteristic (as explained above), while a thin deposited TCO will be unable to provide both of these characteristics.

Furthermore, it should be noted that the basic idea to use a transparent contact layer to improve the yield of the arrangement by gathering more light is neither disclosed nor suggested by the prior art at the time of the invention. The basic idea to use transparent contact layer to improve the yield of the arrangement may thus again rather be only found in the present invention. The present invention is thereby based on the new findings of the inventors that using a TCO layer actually significantly improves the yield of the arrangement. This is neither disclosed nor suggested by the prior art at the time of the invention.

For the foregoing reasons, reconsideration and withdrawal of the rejections are requested in view of the amended claims.

Glass Substrate Core

Regarding the spherical or grain-shaped semiconductor elements, the official action relies on substitution of materials of Nakata with those of Probst to arrive at a spherical solar cell with a Mo back contact layer and a CdS buffer layer.

Claim 16 has been amended to specify that the substrate core of the semiconductor element that is coated at least with one conductive back contact layer made of molybdenum and with one semiconductor layer made of a I-III-VI compound semiconductor is glass. The applicants submit that Probst does not provide motivation to substitute use of glass for a spherical substrate core instead of the materials specifically taught by Nakata. Such a combination is only motivated by the teachings of the present inventors. The official action alleges a motivation based on selection of known materials based on suitability for an intended use (citing MPEP 2144). However, there has been no showing that suitability of glass for spherical substrate cores in the invention of Nakata was recognized in the prior art (see MPEP 2144.07 – the suitability for an intended purpose must be "art recognized").

Starting from the spherical solar cells of Nakata, which comprise a metal core 21 as substrate (see [0074]), one would accordingly surely not consider dismissing the metal core and using a glass core, since without a barrier layer one would expect reliability issues and with a barrier layer one could not expect any significant effect of this substrate change (the effect in Probst comes from the further addition of a dosed amount of alkali ions).

Moreover, one has also to keep in mind that changing the substrate may obviously lead to adhesion problems with layers deposited on this substrate. In this respect, Probst already discloses that glass as a substrate and a molybdenum back

contact may lead to adhesion problems of the CIS layer even when using flat glass panes as a substrate.

One skilled in the art would thus surely be aware of these possible adhesion related problems.

Moreover, one would expect the adhesion problems to get worse when little spheres are used as a substrate because of their very high curvature (which may lead to stress/tensions in the layers and may further lower adhesion).

Thus, it cannot be said that substitution of of glass for a spherical substrate core in place of the metal cores of Nakata was recognized in the prior art as suitable. With this failure of teaching or recognition in the prior art, there is no basis for *prima facie* obviousness.

Nevertheless, if Nakata were modified in view of Probst, the skilled artisan would not arrive at the structure thus claimed, but rather one in which a diffusion barrier layer is included. See Probst at column 3, lines 56-60:

> Given employment of an alkali-containing substrate, particularly of a glass substrate, additional alkali diffusion from the substrate into the absorber layer during the manufacture thereof is prevented in accordance with this invention by a diffusion barrier layer. Thin layers of silicon nitride, titanium

Nakata also requires use of a diffusion barrier layer, for example a silicon nitride film. See, column 9, lines 20-25:

> formed by low pressure CVD method. The reflective film 2, comprising these two insulating coatings, reflect and disperse incident light. It also prevents impurities contained in core 1 from diffusing and being mixed with the high purity silicon of semiconductor thin film layer which is formed on top of reflective film 2. The minute irregu-

See also column 20, lines 15-16 ("Silicon nitride film 32 prevents the diffusion of impurities from core 31"), column 21, lines 37-38 (silicon nitride film 212), and column 23, lines 17-18 (silicon nitride film 242).

Thus, when the art is combined in an objective way, motivated only by teachings in the prior art, the skilled artisan would arrive at a structure outside the scope of the current claims.

Conclusion

For all the foregoing reasons, all elected claims 16-26, 29-38 and 41-44 are of proper form and scope for allowance, and such action is solicited.

Should the examiner wish to discuss the foregoing or any matter of form in an effort to advance this application toward allowance, she is urged to telephone the undersigned at the indicated number.

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